Open Science Happens Somewhere: Exploring the use of Science OER in Schools

Conference or Workshop Item

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Abstract

This paper concerns a pilot exploring the use of openly licensed content in secondary schools. Specifically it looks at the use of the Open University's (OU) OpenScienceLab (OSL) in two remote rural schools in the West Highlands of Scotland. OSL is a series of online experiments openly licensed for anyone to use, they are about learning through experimentation, and are part of a wider OU interest in how to support and develop inquiry based learning at a distance (Scanlon 2012). This area is of particular relevance to Scottish schools, as the underlying pedagogy of Curriculum for Excellence (CfE) promotes interdisciplinary thinking and learning through inquiry (Macintyre 2014).

The idea of the pilot was to work on how "open content" might be used in schools to understand what openness might mean in and for educational practice. While our initial intention was simply to run these in schools after the first workshops it became apparent while the technical and licences were open and it was relatively clear how to do the experiments, people were uncertain how to use them in their educational practice. Emphasising the need to attend to Educational Practice as well as Openness in OEP.

The pilot took a participatory design approach (Sanders and Westerlund 2011; Mor *et.al* 2012), to developing and support practices around the use of Open Educational Resources (OER) in classroom. Through a series of workshops and schools visits we looked to solve these problems from the classroom out, using the teachers experience to develop learning journeys that worked for teachers and pupils. With teachers we created a learning journey using the OU's free platform OpenLearnWorks to wrap the experiments in a mixture of existing and newly developed OER.

Two journeys were created, these will be run in two locations with with two sets of teachers in December 2014. The paper will report on the outcomes for pupils and teachers of this final stage. In doing so it will reflect on the participatory design process, highlighting the practices developed to support the use of open content, drawing out broader conclusions might support the use open materials in the classroom

Short Paper

1. Introduction

This short paper explores the use of virtual and simulated science experiments from the Open Universities University's (OU) OpenScienceLab[1] in two remote rural secondary schools in the West Highlands of Scotland. It begins with some background to the pilot, looks at how the team from the OU in Scotland and Highland Council[2] approached the work, and discusses the outcomes of the pilot, before concluding with some reflections on what we might do next.

2. Background and Context

A great deal of the attention paid to Open Educational Practices (OEP) in schools has focussed on content; in the US this has tended to be textbooks (Wiley *et.al* 2012), and in the UK the sharing and use of free openly licensed "learning objects"[3]. Education in Scottish Schools Curriculum for Excellence[4] looks at learning through inquiry across disciplines, matching our interest in inquiry based learning and open science (Scanlon 2012). In particular, how simulated and virtual experiments might be used in the classroom, specifically a suite of experiments developed by the OU on a site called OpenScienceLab. Our question was simple, would simulations designed for self directed distance learners work for secondary teachers in the classroom.

3. Methods and Approach

Our experience of working with a wide range of stakeholders on Open Education has led us to approach relationships with organisations as partnerships. The partnership model allows the expertise of each partner to be recognised, supported and utilised (Macintyre 2013; 2014a). We draw heavily on the idea of design thinking in how we structure our approach (Mor *et.al* 2012), in particular approaches to participatory design of educational systems that come from Scandinavia (Bjongvinsson *et.al* 2012; Sanders and Westerlund 2011). Our experience of using OER to co-design emergent learning journeys in the classroom (Macintyre 2014b) led us to emphasise the role of teachers and pupils as action researchers trying to solve practical problems by doing things. This means the focus is not testing what works but on the, process of making it work. This paper reports on two small rural secondary schools in the West Highlands and our relationship with two Principal Teachers and a set of Scottish Higher (S5/S6-16-18 years old) Biology (n=8) and Chemistry (n=22) pupils.

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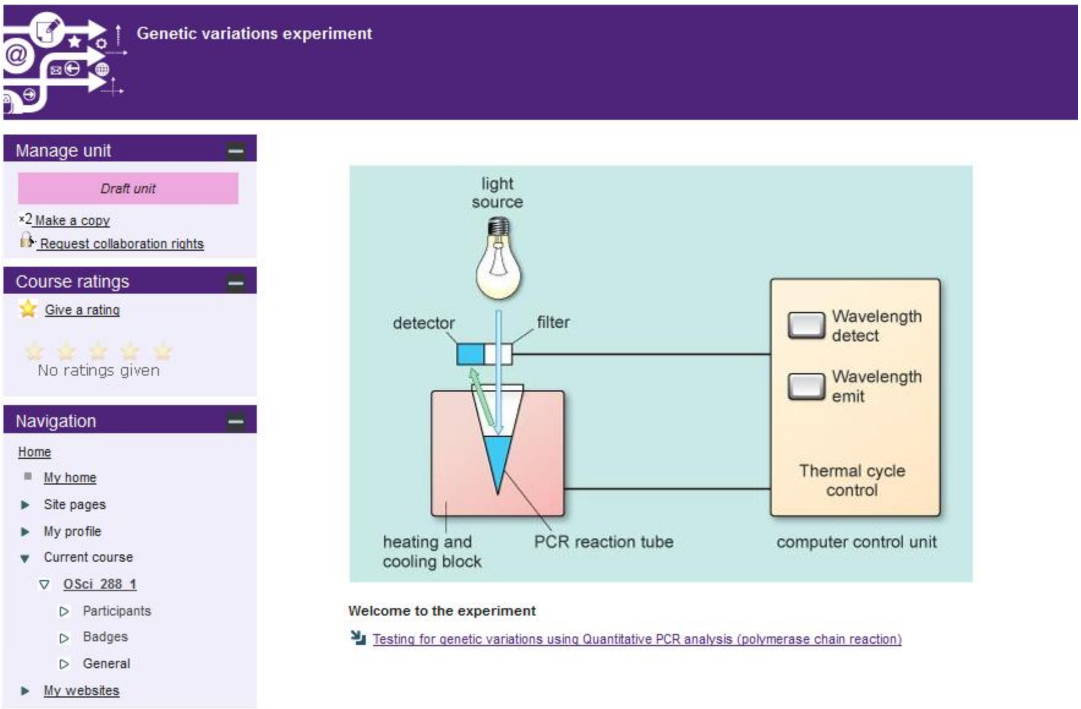
1 OpenScience Lab is hosted here https://learn5.open.ac.uk/course/view.php?id=2

2 Highland Council is the largest unitary authority by area in Europe, the West Highlands are sparsely populated with poor infrastructure and recognised as being an under-developed, see http://en.wikipedia.org/wiki/Scottish_Highlands

3 For example, see this recent conference in England, http://lccdigilit.our.dmu.ac.uk/2015/01/15/oer-schools-conference/

4 You can find out more about it here http://www.educationscotland.gov.uk/learningandteaching/thecurriculum/whatiscurriculumforexcellence/

Figure 1: **Analysing DNA using Polymerase Chain Reaction (PCR) to identify Genetic Variation**

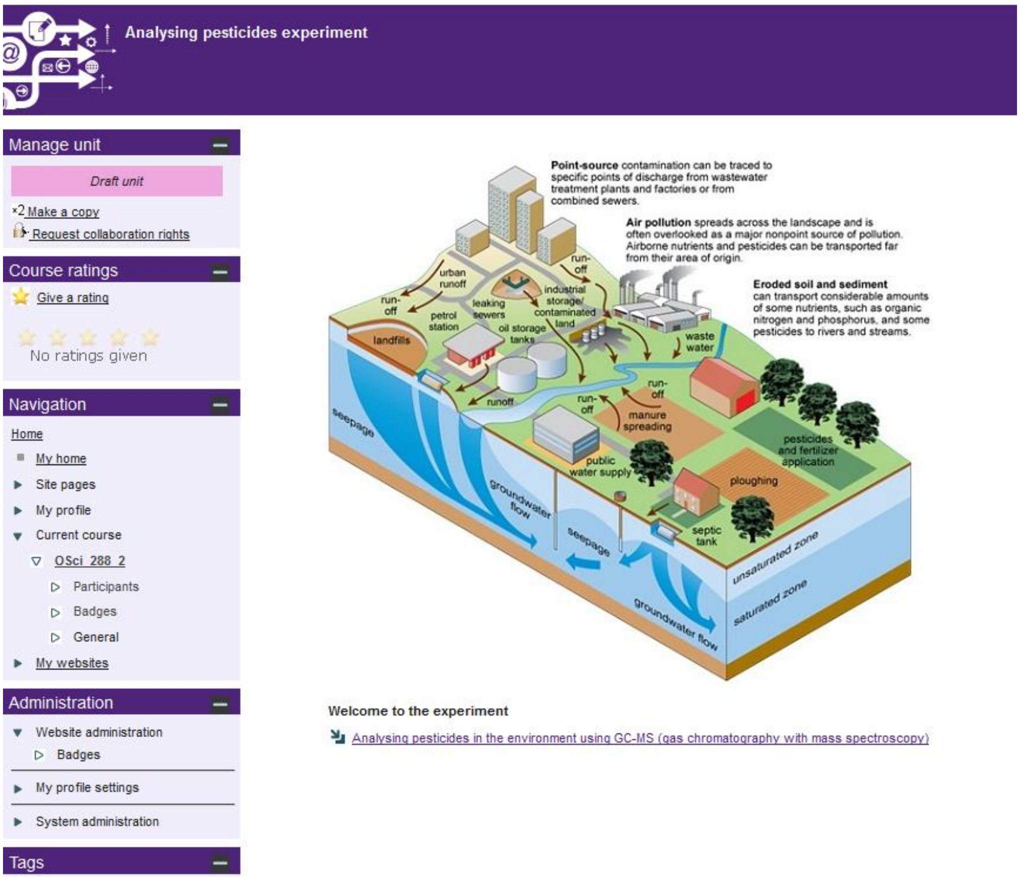


The polymerase chain reaction (PCR) is an important tool in biology, medicine and in forensics. Each of us holds the genetic description of ourselves in the “double helix” DNA of most cells in our bodies. The genes that direct our bodies at a molecular level are sections of these DNA chains. Often, we have multiple copies on an individual gene – which be the same or they may be different. This genetic variety affects our susceptibility to illness. It means that we differ in our responses to medicines – both in effectiveness and in the side-effects.

Students observe the development of data from the samples. From their collection of data, they can look at the outputs from individual samples or groups of samples, and determine numbers of gene copies or even the numbers of specific variants of the gene. So the students are able to see directly the genetic differences between individual people.

- Planning and undertaking practical investigations, testing hypotheses and analysing results
- Applying knowledge, understanding and skills in unfamiliar contexts
- Developing an approach to problem solving through applying scientific inquiry, scientific analytical thinking and problem solving skills
- Processing information using calculations and units
- Developing skills of independent working
- Developing an understanding of biology's role in scientific issues and relevant applications of biology, including the impact these could have on society

Figure 2: **Analysing pesticides in the environment using GC-MS (gas chromatography with mass spectroscopy): An experiment for Higher Chemistry students**



This experiment uses the techniques of gas chromatography and mass spectroscopy to analyse pesticide content in the water of a tidal bay in China. Students develop their own hypotheses about how pesticides are distributed across the bay and test them by devising a sampling plan. The analysis is both qualitative and quantitative, involving matching samples with a library of mass spectra and calculating concentrations using the gas chromatograms.

The associated materials look at the principles behind gas chromatography which form part of the Scottish CSE Higher Chemistry Curriculum. Additionally, students learn a little about mass spectroscopy, giving them a taster of studies at a higher level. The associated materials also ask students to examine the chemical structure of the pesticides, so revising the ideas of structural and molecular formulas and valency. Environmental issues associated with pesticide contamination are also touched on.

By working through the investigation, both the experiment and associated materials, students will learn about the techniques of gas chromatography, mass spectroscopy and their uses. They will also consolidate their understanding of chemical formulas and valency. The activities develop a number of key skills including:

- Planning and undertaking practical investigations, testing hypotheses and

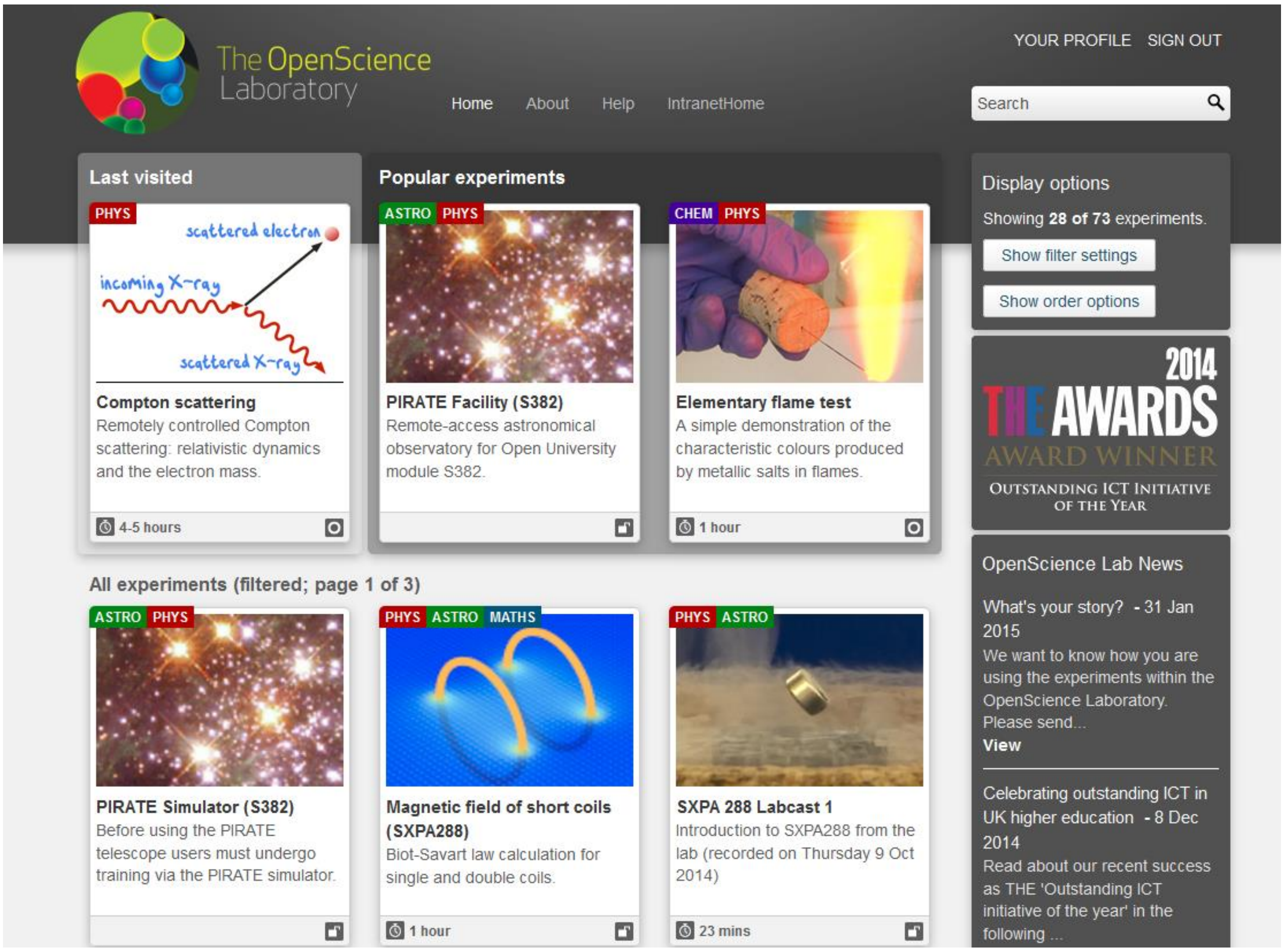
analysing results
- Applying knowledge, understanding and skills in unfamiliar contexts
- Developing an approach to problem solving through applying scientific inquiry, scientific analytical thinking and problem solving skills
- Processing information using calculations and units
- Developing skills of independent working
- Developing an understanding of chemistry's role in scientific issues and relevant applications of chemistry, including the impact these could make in society and the environment

4. Discussion

4.1 Developing a Learning Journey

During the initial meetings we showed teachers (n=6) the experiments, and together we explored how they might work in the classroom. On this basis the team selected two simulations, see Figure 1 and Figure 2. We spent some time exploring the students' present learning journey, looking at how the simulations would fit. It became clear the simulations would not work as stand alone resources. We started working with teachers in two schools mapping out the support pupils would require and the Project Officers were able to draw on the materials they used in their teaching practice. Some of these materials were not presently in the open but part of the OU's closed accredited curriculum. Revisions for openness was not simply about text, but how the text operated in the world. The context of the classroom rather than the distance learner was important in designing a learning journey, but so was the sense of equality of experience for those not able to be in the classroom. In the end we designed a learning journey that was a mix of face to face lesson plans and heavily remixed material from the experiments' original context. In essence, blended learning. We used our openly licensed "sandbox" platform OpenLearnWorks to wrap the materials round the simulations in OpenScienceLab – see Figure 3.

Figure 3: **Home Page of Open Science Lab Showing some of the Experiments**



4.2 Use and ReUse Value

In addition to aligning with the curriculum and fitting open content into classroom practice we also needed to address where learners were in their learning journey. This was woven into the design process, but it is worth teasing out one example here. In Biology the pupils had already covered DNA and sequencing which was the basis of the experiment (see Figure 1) in the classroom. The pilot sessions ran just before the winter break and the Higher Preliminary Exams. It was revision, but revision through a different lens, rather than repetition, pupils needed to refresh and apply existing subject knowledge to an experiment that they knew “in theory but not in practice”. What we observed was that pupils moved quickly through the content in the classroom, sometimes quietly reading, sometimes asking their teacher but often talking and discussing items with their peers. When it came to the simulation things slowed, pupils became less certain and more curious. In developing the journey we had focussed on content that supported the interpretation of the results. What we did not anticipate was the questions about the PCR machine. We had provided support on the why and some on the what, but not enough on how it performed these functions, the mechanics of it. Afterwards we reflected that even though the simulation was mediated through a PC, pupils were thinking about the embodied actions of doing the experiment and the socio-material relationships (Fenwick 2010). The experiment is a simulation, it is about computers in classrooms, but in projecting the learner into the lab it seemed to have highlighted distance and the lack of materiality in a useful way. The learners wanted to cross that distance, through learning more about the machines. To use an analogy from the visual arts, closing that interpretive space becomes part of the experience (Clark 2006), of the learning journey, and something we need to account for in future iterations.

4.3 Its Online so What

We also wanted to look at how the pupils experienced and understood online learning. What was interesting was the non response. Pupils volunteered issues, for example, poor rural broadband meant some people might not be able to access it, or lack of home access to PC's. Though when you asked for examples, it was something that happened to other people. Pupils seemed to pull out abstract examples of digital exclusion to meet our expectations rather than to represent their experience. It was a normal way to learn and as rural residents it might be constrained by infrastructure or socio-economic factors, but constraints were not pedagogic.

Our sense was the pupils saw these online resources as an extension of the classroom. The computers were part of the socio-material assemblages (Fenwich 2010) in the class, binary separations were meaningless. One might be tempted to evoke the idea of “digital natives”, however, a more useful frame is to think about digital residents and digital visitors (White and Le Cornu 2011). Perhaps extending the metaphor to reflect on what constitutes an educational space, and coming to think of these online resources as part of the physical spaces we occupy as we learn (Macintyre In Progress).

4. Looking Forward

We learnt some very practical things through this pilot. While these online simulations were free and open, the degree to which those freedoms could be exercised was constrained. These constraints were not technical but contextual, they related to teaching practice, to imagining how they might be used. As an open object an experiment or simulation is very different from openly licensed textual content, it cannot afford all of the 5R's; for example often functionality is based on a structural integrity that means it cannot easily or affordably be revised or remixed. Our solution to an immutable learning object is a simple, wrap the simulations in a VLE based learning journey.

The lesson for us was the importance of context; in releasing things openly we need think about the educational contexts in which they might be useful and used. This is not a call for the creation of highly contextualised OER, rather it is observation on how we place free and open content, its place, its role is for doing (Kemmis 2010), and if we are to realise educational freedoms afforded by openness we need to address educational practice directly. In addressing those educational practices we can begin to see what Open Educational Practices ought to explore and it is clear as the OEP/OER field matures we need a sharper focus on the practice of education (Macintyre 2014a; 2014c). This means engaging in practice based research, a focus on doing things that help us unpick how to enable openness and what openness enables.

Word Count: 1900

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